Sunspot Pattern Classification using PCA and Neural Networks

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Overall Research Goal : Unsupervised spatio-temporal-spectral classification of real-time MDI images
Pre-history analysis of solar active regions
Real time prediction of solar flare events

Initial Objective : Autonomous classification of sunspots based on MDI images using artificial intelligence algorithms

Procedure :

(i) Reduction of data set for constructing suitable training data set for PCA and neural network
- Select standardized image size and color resolution (183 x 183 pixel)
- Resize image to a size, so that equal number of metapixels can be generated

(ii) Construct a training data set for PCA, so that the highest eigenvalues for each class can be stored

(iii) Eigenvalue is computed for a new image and is compared with training dataset for class assignment

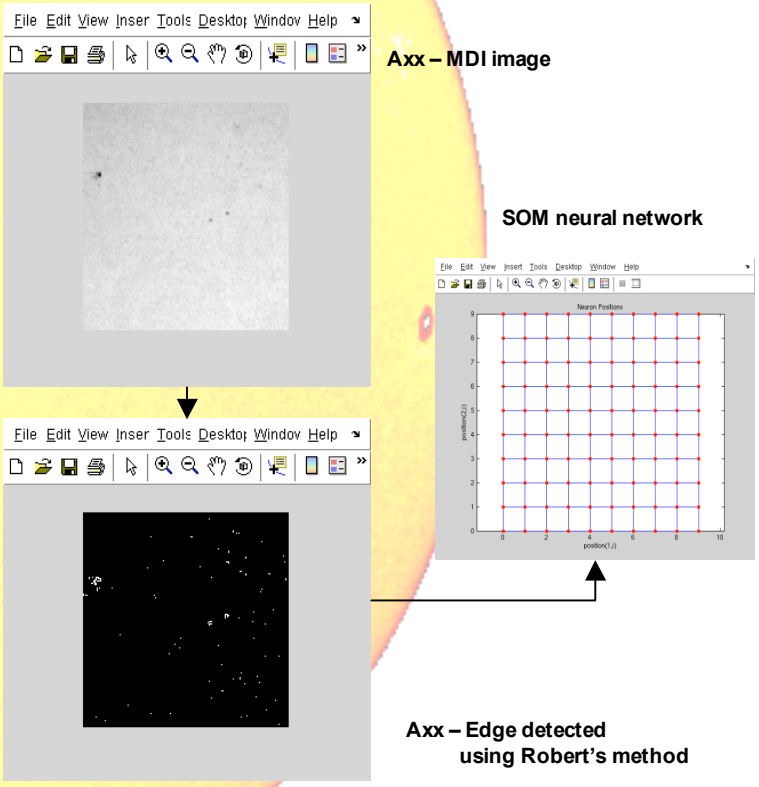
(iv) Based on threshold value, if the class is not able to be determined, then unknown class is designated

(v) PCA -> Data reduction for training data set construction

(vi) The image is divided into equal number of metapixels

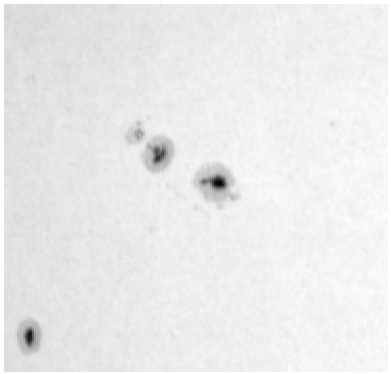
(vii) The mean and SD values of the grid are provided as inputs to the neural network w.r.t corresponding classes

(viii) SOM Neural network is trained and ready to predict future classification of images (using only 1/6 of available images)

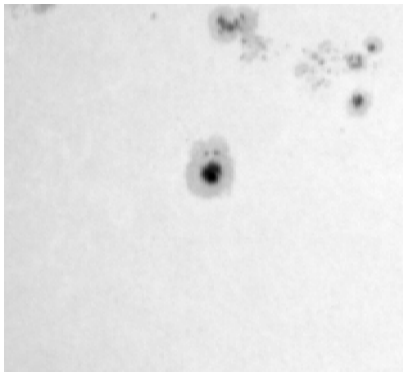


Data : MDI images 05 March 2001 – 26 December 2004
3 arcmin square
Original data set size : 1596
Training data set construction : 308

Initial Results : Classification based on PCA Maximum eigenvalues for 15 McIntosh classes of sunspot configurations



Cao



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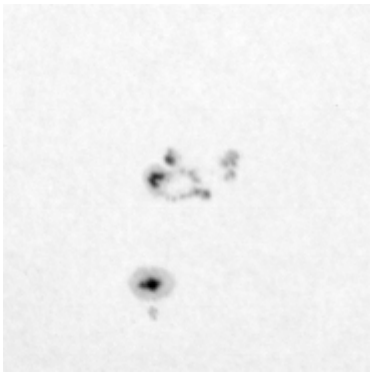
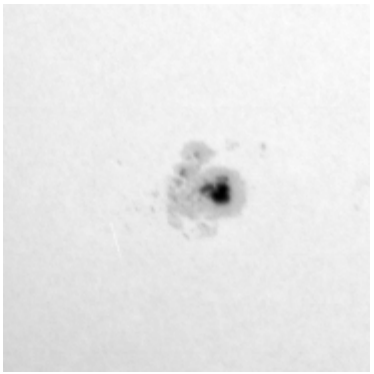


Dai



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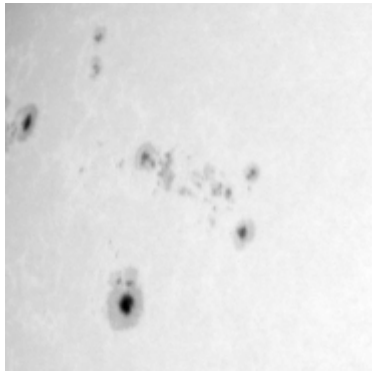
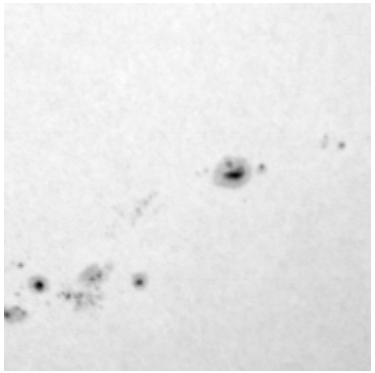


Eai



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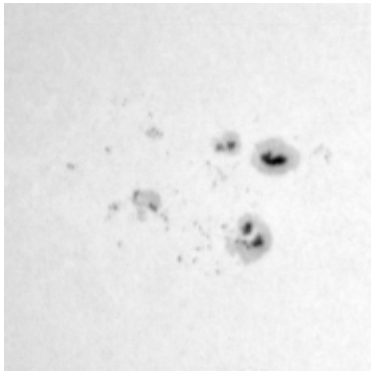

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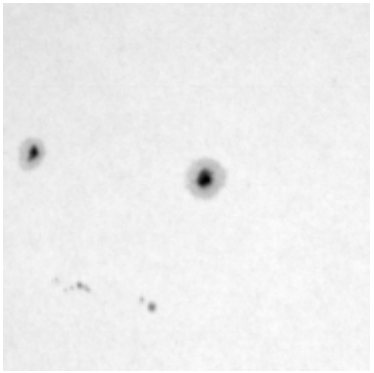
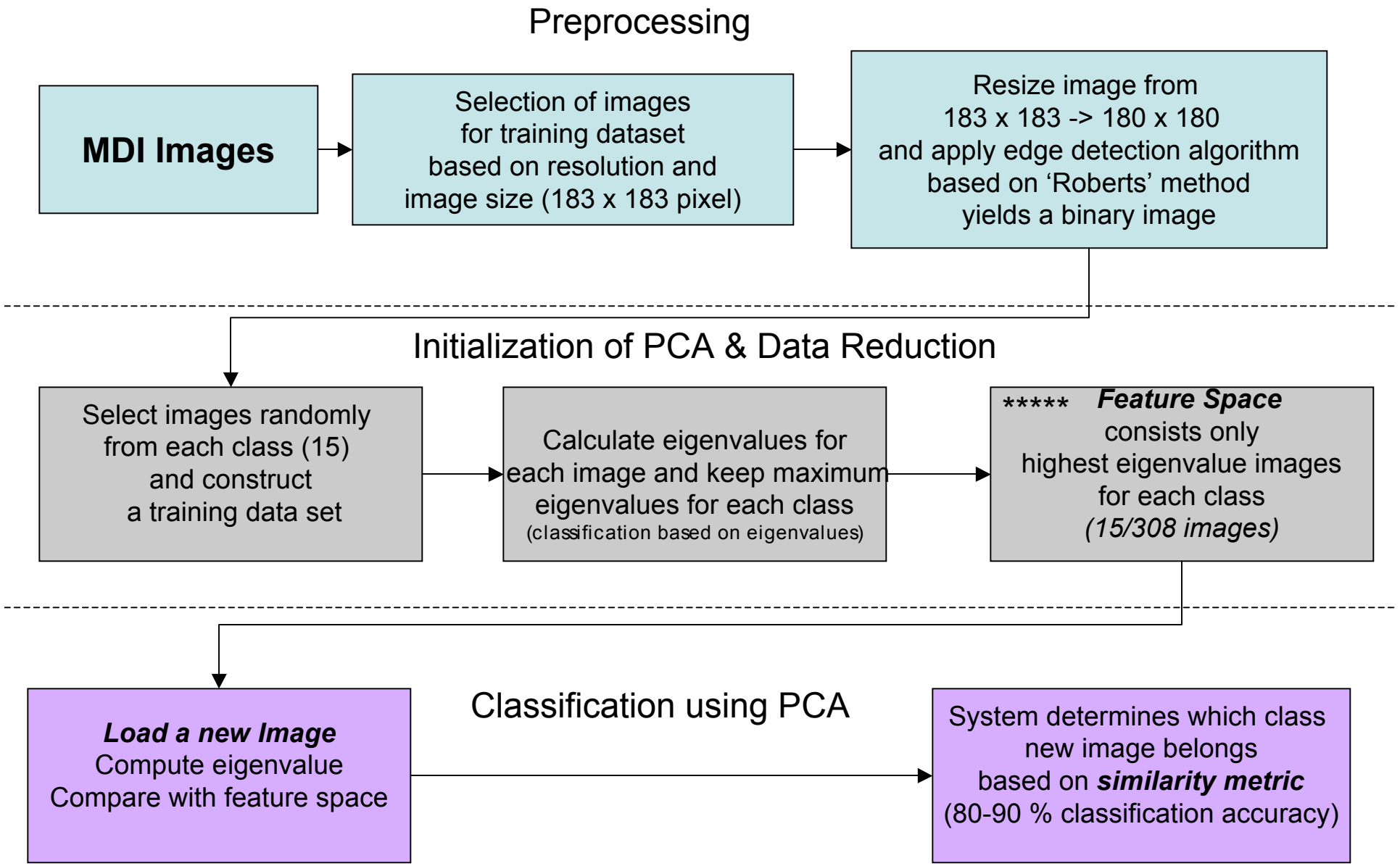
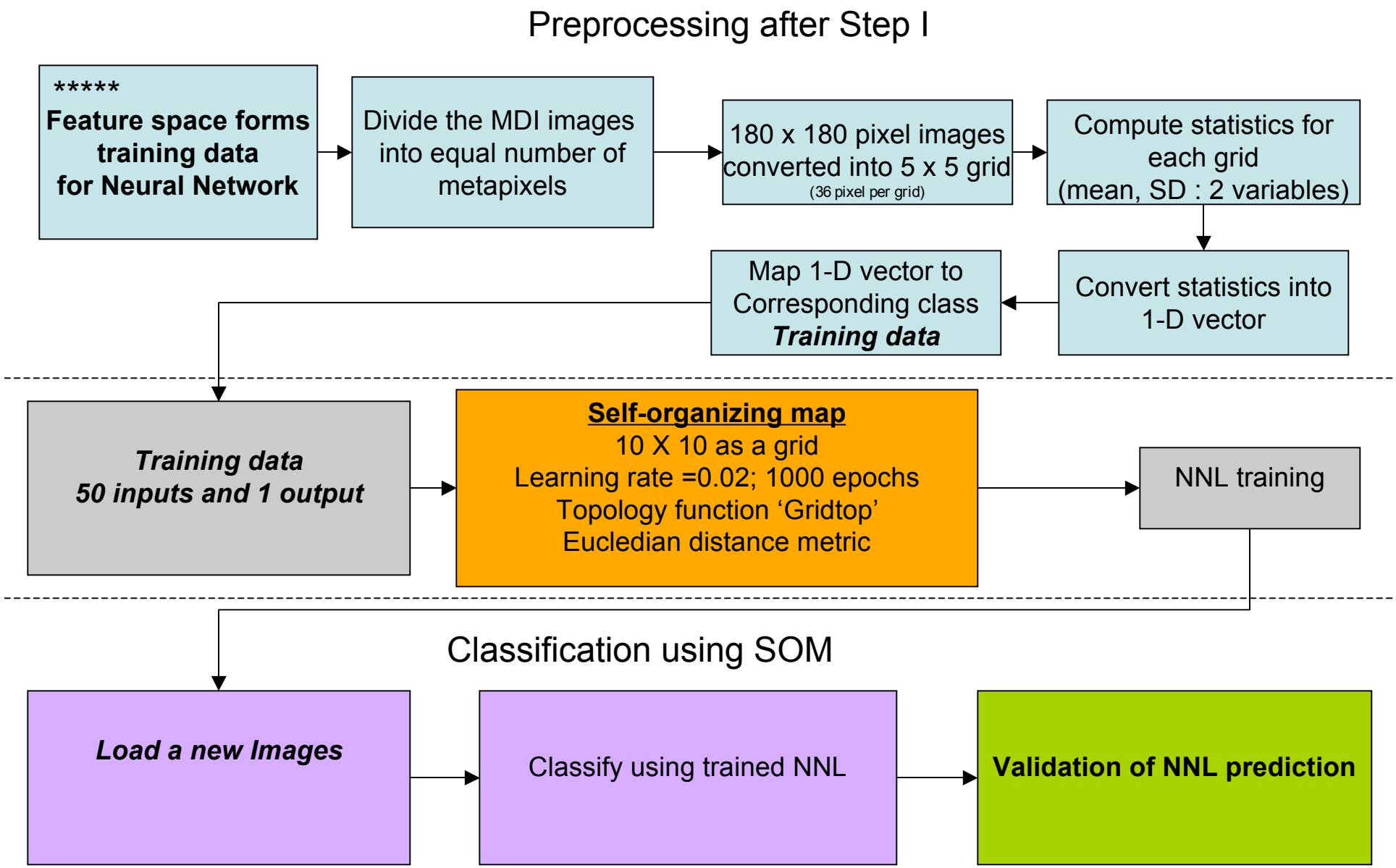


Hsx

Sample images from different sunspot classes



Step I Classification of Sunspot using PCA



Step II Further Refinement in Classification of Sunspot using Self-organizing Map